63D CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 871.

SANDUSKY HARBOR, OHIO.

LETTER

FROM

THE ACTING SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORTS ON PRELIMINARY EXAMINATION AND SURVEY OF SANDUSKY HARBOR, OHIO.

March 31, 1914.—Referred to the Committee on Rivers and Harbors and ordered to be printed, with illustrations.

WAR DEPARTMENT,
Washington, March 28, 1914.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers, United States Army, dated 27th instant, together with copies of reports from Maj. Charles S. Bromwell, Corps of Engineers, dated June 2, 1913, and February 17, 1914, with maps, on preliminary examination and survey, respectively, of Sandusky Harbor, Ohio, made by him in compliance with the provisions of the river and harbor act approved March 4, 1913.

Very respectfully,

HENRY BRECKINRIDGE,
Acting Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, March 27, 1914.

From: The Chief of Engineers, United States Army.
To: The Secretary of War.
Subject: Preliminary examination and survey of Sandusky Harbor, Ohio.

1. There are submitted herewith, for transmission to Congress, reports dated June 2, 1913, and February 17, 1914, with maps, by Maj. Charles S. Bromwell, Corps of Engineers, on preliminary examination and survey, respectively, of Sandusky Harbor, Ohio, authorized by the river and harbor act approved March 4, 1913.

2. The existing project for improvement of Sandusky Harbor provides for an outer channel 300 feet wide, a straight inner channel 400 feet wide leading to the wharves at Sandusky, and a channel 300 to 550 feet wide along the dock front, all to a depth of 21 feet at mean lake level, the extension of the east jetty to a total length of 5,000 feet, the construction of a west jetty 5,550 feet long, a brush and stone sill about 8,000 feet long extending from Sand Point to the range light opposite Cedar Point, and several minor dikes and jetties for local protection. On account of the fluctuation of water level under wind action and the periodic deterioration of the dock channel where it is underlaid by rock, the project depth of 21 feet below mean lake level is not generally available to navigation. The commerce of the harbor has been growing rapidly and the present depth does not properly accommodate the larger vessels now in use. The district officer is of opinion that it is advisable to defer for the present the construction of the west jetty and of the dam or sill extending from Sand Point; to extend the east jetty to a total length of 6,000 feet, with a pierhead at its outer end; to dredge the outer bar channel, the straight channel, and the easterly part of the dock channel to a depth of 23 feet at mean lake level, and to excavate the westerly part of the dock channel to a depth of 22 feet at mean lake level, at a total estimated cost of $282,000, provided the city of Sandusky will contribute to the cost of such improvements the sum of $50,000 to be used in the improvement of the dock channel. The division engineer concurs in the views of the district officer.

3. These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its report herewith, dated March 11, 1914, concurring with the views of the district officer and the division engineer.

4. After due consideration of the above-mentioned reports, I concur with the views of the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore report that the further improvement of Sandusky Harbor, Ohio, is deemed advisable so far as to extend the east jetty to a total length of 6,000 feet with a pierhead at its outer end; to dredge the outer bar channel, the straight channel, and the eastern part of the dock channel to a depth of 23 feet at mean lake level, and to excavate the western part of the dock channel to a depth of 22 feet at mean lake level, all with widths as now contemplated by the existing project, at a total estimated cost of $282,000 and $5,000 annually for maintenance, provided that the city of Sandusky will contribute the sum of $50,000 toward said improvement before operations thereon are undertaken by the United States. The first appropriation should be $150,000 and the work so prosecuted as to complete it in two years.

DAN C. KINGMAN,
Chief of Engineers, United States Army.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

[Third indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
March 11, 1914.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

1. Under the various projects adopted for the improvement of this harbor described in detail by the district officer there have been constructed certain dikes and jetties and a channel about 6 miles in length, having a depth of 21 feet at mean lake level. The total expenditures under the existing project have amounted to about $753,000. The amount expended on the earlier projects was about $477,000.

2. The commerce of the port has been increasing and now amounts to approximately 2,970,000 tons, of which about 2,523,000 tons is coal. There has been a marked tendency in recent years to use larger vessels. The number engaged in Lake Erie traffic having a capacity of 5,000 tons or over has increased from about 17 per cent to 23 per cent in the past five years. In 1912 there were 84 cargoes at Sandusky handled by vessels of the largest type, having a length of 500 feet or more. It is stated that the business of the harbor has about doubled in the past five years.

3. While the present project provides a depth of 21 feet below mean lake level, the district officer states that this depth is not generally available for navigation, due to periodic deterioration and the fluctuations of the water level under wind action. The maximum variation of water level between May 1, 1909, and May 1, 1913, was 5.95 feet, the maximum variation of monthly means being 3.07 feet.

4. The east jetty was limited in length to 5,000 feet at the time of the adoption of an 18-foot depth, and its length was not changed when the depth was increased. It is stated that the effect of the jetty in maintaining the channel has been marked, but an extension appears desirable in order to maintain a greater depth.

5. Investigations of the district officer in connection with his preliminary report led him to the conclusion that the locality was worthy of further improvement by extending the east jetty, increasing the channel depth to 23 feet below mean lake level, and providing an opening through the east jetty for the use of small craft. After a further study of conditions made in connection with the survey he has concluded that an extension of the east jetty for a distance of 1,000 feet is desirable both for the maintenance of the channel and for the safety of navigation; that the outer end of the jetty should be marked by a pierhead; and that the project depths should be increased to 23 feet below mean lake level in the approach channels and to 22 feet in the westerly dock channels, so as to permit safe navigation at low water for vessels of 19-foot draft.

6. The existence of rock in the dock channel is an important factor in determining the depth to which excavation should be carried at that place. The survey develops that the greatest depth that can be given economically is 22 feet below mean lake level, and the district officer adopts this as the depth for the westerly portion of the dock channel, but recommends a depth of 23 feet for

the channels of approach. He does not believe it necessary or advisable to provide the opening in the east jetty for the use of small vessels contemplated at the time of the preliminary examination. The total estimate for the work proposed is $282,000.

7. It appears that the city of Sandusky is willing to cooperate in the work of further improvement by contributing the sum of $50,000 under certain conditions specified by it. The project proposed by the district officer does not fully meet these conditions, but he recommends the further improvement outlined above, at a total cost of $282,000 for first construction and $5,000 annually for maintenance, provided the city contributes $50,000 to this work. The division engineer is in accord with the views of the district officer.

8. From the information now in hand it appears that the commerce of this harbor has been growing rapidly and that the present depth does not properly accommodate the larger vessels now in use. While the existing project provides for a depth of 21 feet at mean low water, this depth is not at all times available, due principally to the oscillation of the water surface caused by the winds. An analysis of the data furnished indicates that in order to have at all times available a depth safe for vessels drawing about 19 feet, the channel should be given a depth of about 23 feet below mean lake level. This is economically practicable in the outer channel, in the channel approaching the city of Sandusky, and in the eastern part of the dock channel, but not in the western part, due to the existence of ledge rock. The east jetty has been effective in maintaining the channel over the outer bar, and its extension as proposed seems to be advisable.

9. It is believed that present and prospective commerce is sufficient to justify further improvement, and the board concurs with the district officer and the division engineer in recommending a modification of the existing project so as to provide for an extension of the east jetty 1,000 feet, making its total length 6,000 feet, the construction of a pierhead at the outer end of said jetty, the dredging of the channels to their present projected width and to a depth of 23 feet below mean lake level in the approach channels, including the eastern part of the dock channel, and to 22 feet in the western part of the dock channel, at a total estimated cost of $282,000, provided that before any work toward the execution of this modified project is undertaken the city of Sandusky shall contribute $50,000. The estimate for maintenance is $5,000 annually. The first appropriation should be $150,000 and the work so prosecuted as to complete it in two years.

10. In compliance with law, the board reports that except as contemplated by the above recommendations, there are no questions of terminal facilities, water power, or other subjects so related to the project proposed that they may be coordinated therewith to lessen the cost and compensate the Government for expenditures made in the interests of navigation.

For the board:

W. M. Black,
Colonel, Corps of Engineers,
Senior Member of the Board.

PRELIMINARY EXAMINATION OF SANDUSKY HARBOR, OHIO.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, June 2, 1913.

From: The District Engineer Officer.
To: The Chief of Engineers, United States Army
(Through the Division Engineer).
Subject: Preliminary examination of Sandusky Harbor, Ohio.

1. The river and harbor act approved March 4, 1913, contains the following provision:

> The Secretary of War is hereby authorized and directed to cause preliminary examinations to be made at the following named localities: * * * Sandusky Harbor, Ohio.

This duty was assigned this office by department letter of March 18, 1913.

2. The harbor of Sandusky consists of lower Sandusky Bay, and is located about 60 miles west of Cleveland. The entire bay forms a natural harbor about 22½ square miles in area, separated from Lake Erie on the north and northwest and protected by a long, narrow peninsula known as Sand Point (formerly called Peninsula Point), and on the northeast by another point known as Cedar Point. The waters of the bay, in general but 8 to 12 feet deep, are further protected from the effect of storms on the lake by a bar which extends nearly across the entrance to the bay, the channel passing close to Cedar Point. The depth of water over the bar is in general from 4 to 6 feet deep.

3. As early as 1826, $400 was allotted for a survey of the locality. The first improvement, however, was not undertaken until 1844, when the sum of $15,000 was appropriated. The project then adopted provided for the construction of protecting works at Peninsula (now) Sand Point. Work under this project was continued until 1854, but in 1864 the works had been entirely carried away, together with a large portion of the peninsula which they protected.

In 1866 a project was adopted which provided for the improvement of the natural channel leading from the bay to the city wharves. This natural channel was very crooked and had a length of about 4½ miles, but its improvement was regarded as the most economical method of providing for the small craft then using the harbor. The project called for a channel 200 feet wide and 14 feet deep. The depth was later increased to 15 feet, but this latter depth stopped at the 12-foot curve, over a mile from the wharves of the city.

In 1879 the project was modified to obtain a channel 15 feet deep at low water across the outer bar to Cedar Point, a distance of about 1 mile; thence nearly west 1¼ miles; thence a little west of south about one-half mile; thence a little east of south 1½ miles to within 50 feet of the city docks, terminating on the prolongation of Columbus Avenue.

In 1880 the project was again modified to include a channel parallel with the city docks and 100 feet wide.

4. The present project for improvement, although subsequently modified and enlarged in its scope, was adopted by the river and harbor act of 1888, and was based upon the report published in House Document No. 78, Forty-ninth Congress, second session, and republished in the Report of the Chief of Engineers, 1887, page 2337. This

project provided for a straight channel 200 feet wide, 17 feet deep, and about $1\frac{1}{8}$ miles long from the north end of Cedar Point to the east end of the dock channel.

In 1894 this project was modified to provide a channel 18 feet deep and 300 feet wide over the outer bar; the construction of jetty 2,500 feet in length, starting from the outer end of Cedar Point and running parallel along the easterly side of this channel; a dike 2,500 feet long to the westward of and parallel to the channel; and dredging the dock channel for a length of 6,500 feet to a width of 200 feet and a depth of 17 feet at mean lake level.

In 1898 this project was further modified, the modification being based upon the examination and survey authorized by the river and harbor act of June 3, 1896, report of which was published in House Document No. 362, Fifty-fifth Congress, second session, and republished in the Report of the Chief of Engineers, 1898, page 2708. This project provided for the extension of the east jetty from Cedar Point to a total distance of 5,000 feet; for the construction of a brush and stone sill about 8,000 feet in length, extending from Sand Point to the front range light opposite Cedar Point; for the protection of the slope adjacent to the channel in the vicinity of the front range light with a brush and stone mattress; for the construction of a west jetty 5,550 feet long extending from the front range light parallel to and 725 feet distant from the east jetty; and for the construction of a deflecting dike about 1,500 feet long opposite and parallel to the outer portion of the straight channel. The estimated cost of the proposed improvements, not included in the previous project, was $240,796.

The project was again modified by the river and harbor act of June 13, 1902, in accordance with a report published in House Document No. 120, Fifty-sixth Congress, second session, and republished in the Report of the Chief of Engineers, 1901, page 3276. It provided for dredging a straight channnel to a depth of 21 feet at mean lake level and a width of 400 feet at the bottom, with slopes of one on two; dredging the dock channel to a depth of 21 feet and a width of 300–550 feet, at an estimated cost of $781,000; and for maintenance, $10,000 a year.

The act of March 3, 1905, modified the project by omitting therefrom the excavation of rock in the dock channel, other than that already provided for by contract, and fixed the limit of expenditures at $815,000, but this work was restored to the project by the act of March 3, 1907. In the interim the city of Sandusky had removed a considerable amount of rock from the channel.

In compliance with the river and harbor act of June 25, 1910, a preliminary examination of Sandusky Harbor was made. The resulting report, published in House Document No. 78, Sixty-second Congress, first session, was adverse to any modification of existing projects.

5. The channel provided under the earlier projects has been abandoned. Under the present project the following has been accomplished: The outer, straight, and dock channels have been completed with the exception of a small area adjacent to the city wharves which, it is expected, will be dredged during the season 1913; the east jetty has been built out from Cedar Point a distance of about 3,500 feet, and a contract is in force under which it will be extended to

a total length of 5,000 feet; 800 feet of the sill designed to extend to Sand Point from the range light, 108 feet of the west jetty, the spur dike extending from Cedar Point toward the channel, and the protection work in the vicinity of the range light have been built as indicated on the accompanying map. Project depths have been maintained but not the full project widths. The United States has expended on the present project up to May 1, 1913, $737,164.03, of which amount $49,615.55 has been for maintenance during the past 10 years.

6. The portion of Sandusky Harbor used for commercial navigation purposes is situated along the dock channel frontage of the city, and is about 1¾ miles in length. It is developed as a series of alternate docks and slips extending out from the shore about 800 feet approximately normal to the dredged channel. No monopoly of the harbor exists, as the docks are owned and controlled by a variety of interests. Three coal-loading docks are operated, one of which, a modern car dumper, is controlled by the Pennsylvania Railroad Co., which, according to its local representative, is about to increase its facilities at a probable cost of $1,000,000. Several manufacturing plants are located on the dock front, many of which receive lumber and other raw materials by water. The Kelley Island Lime & Transport Co. is now building a dock which is to be used as a landing for a car ferry which it will operate across the bay to furnish more direct connection with its limestone quarries at Marblehead, Ohio. Sandusky Harbor is also the base of supplies and the outlet for the group of islands located in Lake Erie in its vicinity, and the island freight traffic, while not large, is important, as is the considerable passenger business which exists. Five railroad lines have access to the harbor front, viz, the Lake Shore & Michigan Southern Railway, the Lake Erie & Western Railway, the Cleveland, Cincinnati, Chicago & St. Louis Railway, the Pennsylvania Co., and the Baltimore & Ohio Railroad. Wharves owned by the city are leased to the Pennsylvania Railroad, and no other public space is available for the development of docks, except at street ends. The coal docks are open to all vessels fueling or taking cargoes of coal, and are equipped with handling machinery. Many of the privately owned docks are semipublic in character and are open on equal terms to all shippers. Practically all of the docks are served by the railroads, and transfer facilities exist where the nature of the business handled is such as to require them. No additional public facilities are necessary at the present time.

7. The traffic of the harbor is indicated by the following figures: In 1912, 3,011 vessels, with an aggregate net registered tonnage of 3,727,868, entered or left the harbor; of this number 41.1 per cent were loaded with freight, 13.5 per cent carried passengers and merchandise, and 45.4 per cent were light; of the loaded tonnage 87.3 per cent carried coal, 1.1 per cent carried grain, 0.4 per cent carried lumber, and 11.2 per cent carried miscellaneous freight; of the tonnage of vessels carrying coal, 14.4 per cent was of vessels of 5,000 net registered tons or over, 49.1 per cent of vessels of 3,000 to 5,000 tons, 29.2 per cent of vessels of 1,000 to 3,000 tons, and 7.3 per cent of vessels of less than 1,000 tons; 2,970,626 tons of freight were handled, of which 2,523,755 was coal; the estimated value of freight was $10,317,000.

The tendency toward the use of large carriers is very marked. Of the total net registered tonnage for the eight harbors in this district the percentage comprised of vessels of 5,000 tons and over has increased from about 17 per cent to about 23 per cent in the last five years. At Sandusky, during the season 1912, over 63 per cent of the coal was handled in vessels of more than 3,000 net registered tons, and 84 cargoes were handled by the largest type of lake vessels—those 500 feet or more in length.

Following are the receipts, shipments, and estimated value of freight for the past five years:

Year.	Receipts.	Shipments.	Value.
	Short tons.	*Short tons.*	
1908	231,000	1,064,000	$5,252,000
1909	315,000	1,272,000	4,996,000
1910	356,000	1,334,000	4,951,000
1911	343,000	1,441,000	6,580,000
1912	430,000	2,540,000	10,317,000

It will be noted that the business of the harbor has about doubled in five years, and it may reasonably be expected that this growth will continue.

The improvements proposed by the Pennsylvania Co. will greatly increase the coal shipments. It is understood that consideration has also been given the establishment of ore docks. Such a development appears likely, as it would afford a two-way business for both railroad and vessel interests, and is a condition which exists at every other harbor of importance in this district. The very considerable unoccupied frontage along the channel which can be developed at moderate expense is also favorable to still further extension of terminal facilities.

8. The law does not specify any particular scope for the examination, but it was ascertained that those interested in securing it had in mind the consideration of two improvements, viz, deepening the channel to 24 feet below mean lake level, and extending the east jetty to deep water in the lake and terminating it with a pierhead suitable for a light and fog-signal station. It futher developed that the small navigation interests are desirous that an opening be provided in the east jetty at a point some 3,000 feet from its inner end of sufficient width and depth to permit the smaller craft to enter and leave the harbor without rounding the outer end of the jetty. A public hearing was held in connection with the investigation and a brief [1] of the minutes accompanies this report.

9. The existing conditions at Sandusky Harbor are such that each of these suggestions appears worthy of serious consideration. The present project provides a depth of 21 feet below mean lake level, but this is not the "navigable" depth. Since 1900, when this depth was recommended, there has been a very great increase in the number of large vessels and a correspondingly growing demand for increased depths in channels. In the westerly portion of the "dock channel" at Sandusky it was necessary to remove bedrock to secure the project depth, and the maintenance of this portion of the channel is difficult

[1] Not printed.

and expensive since, on account of the nature of the bottom it is impossible to resort to overdepth dredging, it becomes necessary to remove the deposit at frequent intervals and in small quantities to insure the required depth—at once an unsatisfactory and costly method. The cost is further increased by reason of the fact that bowlders are frequently rolled into the channel from the shallower water of the bay and, lying directly on bedrock, can only be removed by securing them with chains with the aid of a diver and hoisting them out, either with the dredge dipper or by the employment of an auxiliary derrick scow. Vessels navigating in a channel of this character very wisely leave an ample margin in loading because of the likelihood of serious damage in striking a rock bottom. There is also to be considered the partial exposure of the channels which results at times in seas of sufficient proportion to render necessary some allowance in the depth for the pitch of vessels.

10. Another and very important factor in the consideration is the fluctuation of water levels. Aside from the seasonal variations and periodical changes in level, which are general on all of the Great Lakes and which consequently regulate the depth to which vessels can safely load, the easterly and westerly extremes of Lake Erie are subject to sudden temporary changes of elevation amounting to about 12 feet, and to changes of perhaps 3 feet continuing for several days, which are caused by the winds. This condition has been recognized at Toledo Harbor where, to secure adequate depths at times of low water, the project now provides a channel depth of 23 feet below mean lake level. Sandusky Bay is located so near the west end of Lake Erie that it is subject to variations which, while not so extensive as are those at Toledo, are nevertheless of sufficient importance to materially affect navigation. The following figures are based upon the results of a series of gauge readings taken from May 1, 1909, to May 1, 1913, and are referred to mean lake level, 1860–1875, elevation 572.77 feet above mean tide at New York:

Maximum variation, 5.95 feet (from −4 to+1.95).
Maximum variation of monthly means, 3.07 feet (from −1.74 to+1.33).
Maximum fluctuation for a 10-hour period, 2.72 feet (from −0.08 to −2.80).
Typical readings for single days during periods of low water:

Date.	7 a. m.	1 p. m.	5 p. m.
Nov. 17, 1909	−3.70	−2.20	−2.40
Jan. 9, 1911	−3.20	−2.20	−1.70
Nov. 13, 1911	−3.60	−2.32	−2.32
Nov. 18, 1911	−4.00	−3.10	−3.20
Jan. 9, 1912	−3.33	−3.50	−3.90

11. The extension of the east jetty has been for some time recognized as a necessity. Its length was limited to 5,000 feet at a time when a depth of but 18 feet was contemplated in the channels and no change in this length was included in the modification of the project which provided for increasing channel depths to 21 feet, although elsewhere it has been common practice to extend jetties to a natural depth in the lake equal to that of the dredged channel. During the progress of dredging operations in the dock channels a considerable quantity of the rock excavated was deposited in prolongation of the jetty which has been completed for a length of

about 3,000 feet. It was the understanding of this office at the time these deposits were made that the length of the jetty was not limited to 5,000 feet by the project, but that it might be extended as necessary to produce a scour sufficient for the creation and maintenance of a channel across the outer bar. Since a length greater than 5,000 feet appeared desirable, under the provisions of the dredging contract, rock was deposited up to 8 feet below mean lake level on the axis of the jetty for a distance of about 2,700 feet beyond the complete section, or to a point about 5,700 feet from the shore. This arrangement has effected a considerable economy in the further construction of the jetty, which is now in progress. Under the project as now understood, however, only 5,000 feet of the jetty can be built, so that there will remain a length of approximately 700 feet of submerged work, which must be regarded as a decided menace rather than a benefit to navigation unless it is completed. The effect of the jetty in maintaining the channel as far as it has been built has been marked and it is believed that by extending it to a natural depth of 22 to 23 feet, which would mean a total length of about 6,500 feet, the scour will be sufficient to maintain the channel with a minimum amount of dredging.

12. There is also required an adequate light and fog-signal station at the entrance to the harbor. The existing range lights are located within the bay and do not serve as satisfactory beacons for the entrance. It is believed, therefore, that in connection with the extension of the jetty it will be advisable to terminate it with a pierhead suitable for this purpose.

13. The suggestion made by the owners of small craft that an opening be left in the east jetty some 3,000 feet from its inner end is prompted by the difficulty which these craft experience in rounding the end of the jetty. During northwesterly storms there is a strong outward current through the channel parallel with the jetty caused by the difference in water-surface elevation in the bay and in the open lake. This current combined with head winds makes entrance difficult and dangerous for fishing tugs and other small vessels of which there is a considerable number using Sandusky Harbor. These boats could, however, approach an opening such as that proposed under shelter of the jetty and effect a comparatively safe entrance. It is believed that a 40-foot opening 6 to 8 feet deep would in no way endanger the channel. It would not be an outlet of sufficient width nor depth to materially reduce the velocity of the current in the channel parallel with the jetty nor to affect its scouring action. Since the depths on the lake side of the cut are greater than the depth of the cut there will be no tendency for material to be carried into the channel from the eastward. There is an urgent request for the channel by the fishermen and by the owners of small boats. Recommendation as to the advisability of making the opening will, however, be made dependent upon a more complete survey of the locality.

14. In connection with the foregoing it appears proper to consider the whole problem of the future development of Sandusky Harbor. With the practical completion of authorized channels and of the east jetty, the next step under the existing project would be the completion of the other works designed to confine the flow of water to the dredged channel across the outer bar and thereby create a scour

sufficient for its maintenance. The necessity for these works, if not indeed the advisability of their construction, is questionable. The effects of works thus far built can now be observed and there can be formed a more accurate conclusion as to further requirements than was possible when the project was adopted. The east jetty, so far as it has been extended, has been entirely effective in maintaining the channel. The scour is very considerable and the current running parallel with it is so strong that it very closely approaches the maximum velocity which can be safely encountered in navigating. No measurement of this velocity has been made, but the above statement is substantiated by the evident scour which, according to recent soundings, has provided a channel about 300 feet wide and 21 to 25 feet deep below mean lake level, as well as by the experience of vesselmen familiar with the harbor. A slight tendency to shoaling at the outer end of the east jetty is noticeable, and for this reason, as well as to eliminate the danger to navigation due to the uncompleted rock fill, the extension of the east jetty seems to be required. It is therefore my opinion that no work other than the further extension of the east jetty is at present required for the preservation of the channel. I am of the opinion that any further confinement of the channel by extending the west jetty or by completing the proposed sill will be apt to result in currents of such velocity that navigation of the channel would be dangerous if not at times even impossible.

15. For these reasons it appears advisable to defer any advancement of the west jetty and other protection works for the present but to extend the east jetty to a total length of 6,500 feet, with a pierhead at its outer end; to dredge the channels to a depth of 23 feet below mean lake level for their full width, this depth being regarded as sufficient for vessels drawing 20 feet; and to cut an opening through the east jetty at a point about 3,000 feet from its shore end of sufficient width and depth to accommodate small boats, provided this cut can be made without endangering the channel in its vicinity.

16. In view of the present and prospective business of Sandusky Harbor I am of the opinion that it is worthy of improvement to the extent outlined in the foregoing paragraph, and I recommend that a survey and estimate of cost be made.

CHAS. S. BROMWELL,
Major, Corps of Engineers.

[First indorsement.]

OFFICE DIVISION ENGINEER, LAKES DIVISION,
Buffalo, N. Y., June 20, 1913.

To the CHIEF OF ENGINEERS:

1. While the commerce of Sandusky Harbor is considerable, the improvements proposed by the district officer imply a cost which may be incommensurate therewith.

2. A survey and estimate of cost is therefore deemed essential to a determination of the worthiness of the improvement by the General Government, and such survey is recommended to cover the three items mentioned in paragraph 15 herein; the cost of east jetty extension to be estimated in lengths of 100 feet.

J. G. WARREN,
Colonel, Corps of Engineers.

[Third indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
July 16, 1913.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY:

For reasons stated herein, the board concurs with the district officer and the division engineer in recommending a survey in order to determine the extent and advisability of the improvement. It is requested that the district officer investigate and report upon the practicability of securing local cooperation to the extent of having the dock channel excavated by local interests to the same depth as that proposed to be provided by the United States in the channels of approach. Further information is also desired as to the frequency, duration, and time of occurrence of the larger fluctuations in lake level, the strength of current in the outer channel, and the draft of coal-laden steamers.

For the board:

LANSING H. BEACH,
Colonel, Corps of Engineers,
Senior Member Present.

SURVEY OF SANDUSKY HARBOR, OHIO.

UNITED STATES ENGINEER OFFICE,
Cleveland, February 17, 1914.

From: The District Engineer Officer.
To: The Chief of Engineers, United States Army
(Through the Division Engineer).
Subject: Report on survey and estimate of Sandusky Harbor, Ohio.

1. In compliance with instructions from the office of the Chief of Engineers dated July 24, 1913, a report is submitted as follows of survey of Sandusky Harbor, Ohio, pursuant to a report of preliminary examination submitted June 2, 1913.

2. The history of the improvement of this harbor and a description of its present condition under the approved project are contained in the report of preliminary examination. That report also contains statistics relating to the commerce of the harbor. The Pennsylvania Co. has begun the work of increasing their coal-loading plant, which was stated therein to be in prospect, and a substantial increase in the business of the harbor is therefore assured.

3. The present disadvantages of the harbor were described in detail in the report of preliminary examination and the proposed remedies were: (*a*) Extending the east jetty to a total length of 6,500 feet; (*b*) deepening the channel to 23 feet below mean lake level; (*c*) cutting an opening through the east jetty for the use of small craft entering or leaving the harbor during storms.

4. The survey was made to cover these items and also the special features designated by the Board of Engineers for Rivers and Harbors in third indorsement on the preliminary examination report. Soundings were taken throughout the channel with a view to determining the amount of excavation of mud and bedrock required to secure channels of various depths; cross sections were taken over the rock fill in prolongation of the east jetty; and current observations were taken in the vicinity of the outer bar channel. From the

survey data maps and plans were compiled, as shown on three tracings submitted herewith.

5. A further study of conditions as brought out by the survey has led to conclusions in modification of (*a*), (*b*), and (*c*), as follows: The extension of the east jetty is considered desirable for two reasons: First, to extend the scouring action of the current along the jetty, and thereby create a practically self-maintaining channel to deeper water in the lake; second, to eliminate the danger to vessels now existing, due to submerged rock which has been deposited beyond the 5,000-foot length now being built under the existing project. It is now my opinion, however, that an extension of but 1,000 feet, inclusive of a pierhead, will accomplish the desired results with a minimum expenditure. Such extension would include all the length of jetty in which submerged stone has already been placed. The amount of stone already in place is about equal to the amount now estimated to complete the extension. Any further extension would therefore be about twice as expensive for equal lengths and would not, it is believed, result in increased benefits commensurate with its cost.

6. It is important, however, for safe navigation, that the outer end of the jetty be adequately marked. The present channel range lights are located well within the bay, and entrance at night is frequently difficult, particularly in foggy weather. It is therefore proposed to terminate the jetty with a pierhead upon which should be located a light and fog-signal station.

7. The advisability of deepening the channels has been carefully considered. The present project provides a depth of 21 feet below mean lake level, elevation 572.8 feet, which depth is generally maintained in the channels of approach, where in places depths in excess of 21 feet also obtain either because of natural deep water, scour, or overdepth maintenance dredging. In the dock channel, however, the controlling depth does not at present exceed 20 feet at mean lake level, as some shoaling has occurred since the project depth was secured. The westerly half of the dock channel is underlaid by bedrock, a considerable quantity of which was broken up and removed in connection with the project improvement. It is this portion of the dock channel that presents the greatest difficulties to navigation. Rock dredging has secured a clear project depth of 21 feet, but the maintenance of this depth frequently involves redredging as the existing project provides for no overdepth dredging. The bottom of the adjoining bay is thickly covered with bowlders, some of which occasionally find their way into the channel. The result is that, except at excessive cost, it is impracticable to maintain channel depths in this section greater than about 20 feet below mean lake level.

8. The draft of vessels loading at Lake Erie ports is largely governed by the depth available in the Detroit River. In general the larger class of vessels load to a depth of 19.5 feet when the lake levels are approximately at their means, but this draft is increased to take advantage of high water and is necessarily decreased when the water is low. The following table shows monthly mean least depths at Sandusky Harbor and in the upbound and downbound channels, Detroit River, for the period January, 1911, to September, 1913.

Month.	Sandusky, referred to—		Detroit River, in—	
	Project depth 21 feet.	Available depth of 20 feet in dock channel.	Amherstburg Channel.	Livingstone Channel (opened for traffic October, 1913).
1911.				
January	19.35	18.35	19.45	.....
February	19.50	18.50	19.47	.....
March	19.26	18.26	19.42	.....
April	19.94	18.94	20.09	.....
May	20.14	19.14	20.30	.....
June	19.99	18.99	20.38	.....
July	19.94	18.94	20.20	.....
August	19.92	18.92	20.11	.....
September	19.80	18.80	20.03	.....
October	19.83	18.83	19.98	.....
November	19.22	18.22	19.44	.....
December	19.60	18.60	19.81	.....
1912.				
January	19.44	18.44	19.81	.....
February	19.35	18.35	19.67	.....
March	19.54	18.54	19.91	.....
April	20.58	19.58	20.63	.....
May	20.89	19.89	20.99	.....
June	20.88	19.88	21.09	.....
July	20.93	19.93	21.01	.....
August	20.80	19.80	20.95	.....
September	20.78	19.78	20.94	.....
October	20.39	19.39	20.53	.....
November	20.03	19.03	20.10	22.90
December	19.56	18.56	19.89	22.69
1913.				
January	20.50	19.50	20.64	23.44
February	20.55	19.55	20.68	23.48
March	20.69	19.69	20.69	23.49
April	22.33	21.33	22.36	25.16
May	22.38	21.38	22.33	25.13
June	22.19	21.19	21.17	24.97
July	21.87	20.87	21.92	24.72
August	21.61	20.61	21.64	24.44
September	21.13	20.13	[1] 22.00	24.00

[1] Channel deepened 0.8 foot.

9. It will be noted that prior to September, 1913, the depth in the Amherstburg channel varied but little from that which would have been available at Sandusky by a 21-foot channel; but it was approximately 1 foot greater than that in the 20-foot channel actually available. Since September 1, 1913, moreover, an increase of 0.8 foot in the depth of the Amherstburg channel has rendered it deeper than the project channel at Sandusky by that amount, and about 1.8 feet deeper than the actual channel. The Livingstone channel in the Detroit River is nearly 4 feet deeper than that at Sandusky. To meet present conditions in the Detroit River, it would therefore be necessary to provide a channel at least 21.8 feet deep below mean lake level at Sandusky.

10. Another factor in the consideration is the temporary fluctuation of levels within Sandusky Bay caused by wind storms. Records available for the period May, 1906, to September, 1913, show that during that time changes in level of more than 1 foot occurred 98 times, and of this number 19 were changes greater than 2 feet. At Cleveland Harbor, which is located about midway on the lake from east to west, and which is consequently comparatively free from sudden changes of level, there were but 27 fluctuations of more than 1 foot, of which but 2 were greater than 2 feet. Typical fluctuations

are shown on the drawings accompanying this report. It is therefore evident that with channels of equal depth Sandusky Harbor would still be at a certain disadvantage, as compared with other harbors less subject to sudden fluctuations of level.

11. Aside from the question of first cost, it would be advisable to remove all rock to a depth considerably below the project depth of channel in order that, for more economical maintenance, the back fill could be removed in larger quantities at less frequent intervals that at present by overdepth dredging. The channel, moreover, would then be at all times comparatively safe, as the danger of grounding on rock would be eliminated.

12. Preliminary estimates prepared with a view to determining how extensive an improvement of the dock channel is advisable show that the cost of rock removal to a depth of 24 feet below mean lake level is prohibitive; and to 23 feet would be out of proportion to the benefits to be derived. To secure a clear depth of 22 feet below mean lake level would involve the removal of but comparatively little bedrock, and the cost of the work would be correspondingly low.

13. It appears, therefore, that the greatest benefit consistent with cost would be secured by a channel 23 feet deep below mean lake level in the outer bar, straight and easterly dock channels, and 22 feet deep in the westerly dock channel. These depths are believed to be ample, at mean lake level, for vessels drawing 21 feet. "Mean lake level" referred to here and elsewhere in this report is a datum plane 572.8 feet above mean tide at New York. The lowest monthly mean of record is about 2 feet below mean lake level, or 570.8 feet above mean tide at New York. The proposed channel depths referred to mean low water would therefore secure a navigable depth of 19 feet, allowing an excess depth of 2 feet in the outer channels and 1 foot in the westerly dock channel.

14. The suggestion made by owners of small craft that a narrow opening be made through the east jetty for convenience in entering the harbor when the wind is blowing in a direction unfavorable for rounding the jetty does not, upon more mature consideration, appear to be practicable. As the function of the jetty is to confine the flow of water and thus produce a scour across the outer bar, it is believed that any opening would decrease its efficiency in this respect. It is, moreover, doubtful if any large use could be made of it by small craft even if it were provided.

15. The estimated cost of the improvements above outlined and shown on the accompanying maps is as follows:

Extension of east jetty 950 feet to make a total length of 6,000 feet, inclusive of pierhead at its outer end.

Station 50 to 51, 1,540 tons stone, at $1.10	$1,694.00
Station 51 to 52, 1,925 tons stone, at $1.10	2,117.50
Station 52 to 53, 2,175 tons stone, at $1.10	2,392.50
Station 53 to 54, 1,815 tons stone, at $1.10	1,996.50
Station 54 to 55, 1,590 tons stone, at $1.10	1,749.00
Station 55 to 56, 2,030 tons stone, at $1.10	2,233.00
Station 56 to 57, 2,145 tons stone, at $1.10	2,359.50
Station 57 to 58, 3,310 tons stone, at $1.10	3,641.00
Station 58 to 59, 3,845 tons stone, at $1.10	4,229.50
Station 59 to 59+50, 2,125 tons stone, at $1.10	2,337.50
Total	24,750.00
Pierhead, timber crib, and concrete	40,000.00

Dredging:		
Outer bar channel to 23 feet below mean lake level, 55,000 cubic yards, scow measurement, sand and mud, at $0.20..	$11,000	
Straight channel to 23 feet below mean lake level, 150,000 cubic yards, scow measurement, sand and mud, at $0.20..	30,000	
Turnout and dock channel to middle of section 4 to 23 feet below mean lake level, 65,000 cubic yards, scow measurement, mud and silt, at $0.20	13,000	
Dock channel from middle of section 4 westerly to 22 feet below mean lake level, 265,000 cubic yards, scow measurement, silt and blasted rock, at $0.40	106,000	
		$160,000.00
Rock drilling and blasting in dock channel, 125,000 square feet, at $0.25..		31,250.00
		256,000.00
About 10 per cent for contingencies, etc		26,000.00
Total		282,000.00

16. The matter of cooperation was taken up with the officials of the city of Sandusky and a public hearing was held on November 21, 1913, abstract[1] of the minutes of which accompanies this report. As a result of negotiations, the city council under date of February 2, 1914, passed a resolution, a copy of which is herewith, pledging itself to contribute to the cost of this improvement the sum of $50,000, provided that the plans and estimates herein submitted shall be approved by the United States Government and the said improvements shall be made. This is somewhat less than one-third of the amount estimated to be required for the work in the dock channel. While it is believed that the city of Sandusky should cooperate to the extent of contributing half the cost of the improvement of the dock channel, the appropriation made is a substantial one and indicates the willingness of the city to cooperate to the extent of its ability.

17. In the report of preliminary examination, it was recommended to defer for the present the construction of the west jetty and other works designed to protect and maintain the outer channel, as provided for by the existing project. This recommendation was based upon the belief that the need of such works is doubtful, since the east jetty, as far as it has been built, has been effective in maintaining the channel; and that further confinement of channel will be likely to result in dangerous currents at times when sudden changes in water level occur.

18. In accordance with the request of the Board of Engineers for Rivers and Harbors, an attempt was made to secure definite data concerning the strength of the current in the outer channel. The use of floats having proved impracticable, on account of the exposed location, a current meter was installed at the edge of the channel and daily velocity observations were taken from November 8 to December 7, 1913, when on account of ice conditions the observations were stopped. During this period but one storm of consequence occurred, but this was one of such extraordinary violence that the wires leading from the current meter to the recorder became heavily iced and were broken, rendering a complete record of current velocities impossible. Although violent in character, the conditions attending this storm were not such as to produce maximum velocity of current in the channel. The wind had been blowing steadily from the southwest for some hours, and the water in the bay had been

[1] Not printed.

onsiderably lowered, when the wind veered to the northwest and radually increased to storm velocity. The overflow of water from he bay therefore covered a comparatively extended period and no ery high current velocities were to be expected. The highest easured, up to the time the recording was interrupted, was about ¼ miles per hour. Undoubtedly considerably greater currents evelop during the violent summer storms when the wind often ttains its maximum velocity within a few moments and shifts in irection with equal rapidity. Such storms have the effect of pro-ucing sudden changes in level, with consequent strong currents at he entrance to the bay. It is not unreasonable to assume that these rrents attain velocities as high as 3 or 4 miles per hour, and it eems entirely probable that if the outlet to the bay were restricted y the project dam, leaving a clear opening between the jetties of ut 725 feet, the current velocity would be increased sufficiently to terfere seriously with the navigation of the channel.

19. After a careful consideration of the problem and consistent ith the foregoing, it is recommended that the construction of the est jetty and of the dam extending from Sand Point to the channel e deferred for the present; that the east jetty be extended to a total ngth of 6,000 feet, inclusive of a pierhead at its outer end; that a avigable depth of 19 feet below low water (21 feet below mean lake vel) be secured in the channels; all at an estimated cost of $282,000, indicated in the foregoing paragraphs, provided that before any the work is commenced the city of Sandusky shall contribute to e cost of making such improvements to the amount of $50,000, to expended in the improvement of the dock channel.

20. It is further recommended that $5,000 be provided annually r maintenance.

21. I am of the opinion that the present and prospective commerce Sandusky Harbor renders it worthy of the improvement recom-ended.

22. A description of terminals open to the public is contained in the port of preliminary examination. There is ample space for the rther development of terminals, but such development should and all probability will be assumed by municipal and private interests.

23. There are no questions of water power involved or other related terests which will cheapen the cost to the United States, except e proposed cooperation by the city of Sandusky.

24. The jetty and pierhead can be completed in one working ason and the dredging in two seasons. Should Congress adopt the oject an initial appropriation of not less than $150,000 should be ovided.

CHAS. S. BROMWELL,
Major, Corps of Engineers.

[First indorsement.]

OFFICE DIVISION ENGINEER, LAKES DIVISION,
Buffalo, N. Y., February 21, 1914.

) the CHIEF OF ENGINEERS, UNITED STATES ARMY:

Forwarded, concurring in the recommendation of the district icer in paragraph 19 herein.

J. G. WARREN,
Colonel, Corps of Engineers, U. S. Army.

[For report of the Board of Engineers for Rivers and Harbors, see p. 3.]

RESOLUTION OF THE CITY COUNCIL OF SANDUSKY, OHIO, DECLARING IT NECESSARY TO MAKE CERTAIN IMPROVEMENTS IN THE SANDUSKY HARBOR.

Be it resolved by the council of the city of Sandusky, State of Ohio, three-fourths of all members elected thereto concurring:

Whereas, certain plans, specifications, charts, estimates, and other matters and things in relation to proposed improvements in the harbor and channels of Sandusky Bay have been prepared and are now on file in the office of the United States Engineer, at Cleveland, Ohio, and especially pertaining to the extension of the jetty and the widening and deepening of the outer bar channel, the straight channel, and of the dock channel in said harbor, and of the necessary expense of such improvements as set forth in said plans, specifications, charts, and estimates hereinbefore referred to, and being the estimates providing for a 23-foot channel and for the extension of the east jetty, and which said plans and estimates contain the following items as respecting the expense of said proposed improvements, to wit:

Jetty (see sheet No. 1)		$24,750
Pierhead		40,000
Dredging:		
Outer bar channel, 55,000 cubic yards, scow measurement, at $0.20	$11,000	
Straight channel, 150,000 cubic yards, scow measurement, at $0.20	30,000	
Turnout and dock channel to middle of section 4, 65,000 cubic yards, scow measurement, at $0.20	13,000	
Dock channel from middle of section 4 westerly, 265,000 cubic yards, scow measurement, at $0.40	106,000	
		160,000
Rock blasting:		
520,000 square feet, at $0.25	130,000	
135,000 square feet, at $0.10	13,500	
		143,500
		368,250
Plus about 10 per cent for contingencies, etc		36,750
Total		405,000

And, whereas, it is incumbent upon the city of Sandusky to share in the expense of said improvements should the same be made as planned; now, therefore, be it

Resolved by the council of the city of Sandusky, State of Ohio, three-fourths of all the members elected thereto concurring, That in the event that said plans, specifications, charts, and estimates hereinbefore referred to shall be approved by the United States Government, and said improvements shall be made, then and in that case the said city of Sandusky hereby pledges itself to contribute to the cost thereof as hereinbefore set forth, the sum of $50,000.

SEC. 2. This resolution shall take effect and be in force from and after the earliest period allowed by law.

EMIL W. GROB, *President of Council.*

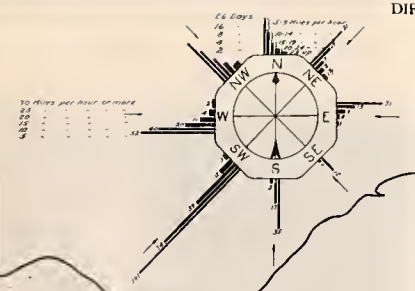
Passed February 2, 1914.

Attest:
E. H. WAGNER, *Clerk.*

Approved February 9, 1914.
[SEAL.]

JACOB DIETZ, *Mayor.*

INDEX MAP



DIRECTION AND VELOCITY OF WINDS
1912
Scales
Length, days
Breadth, miles per hour
Data furnished by the Cleveland Office U.S. Weather Bureau, where it is filed.

SAND POINT

LAKE ERIE

Proposed Spurs

JOHNSON ISLAND

Proposed Sill

Range Light

Completed

Outer Bar Channel

Proposed First Jetty 350' East

Proposed Second Jetty 350' East under construction

Completed

Inner Bar Channel

Range Light

Range Light

Proposed Dike

Range Light

SANDUSKY BAY

CEDAR POINT

STRAIGHT CHANNEL

Dredged and Maintained to Depth of 21 ft.

L.S.&M.S.RY.

WEST DOCK CHANNEL EAST

550

300

SANDUSKY

L.S.&M.S.RY.

C.C.C.&St.L.RY.

B.&O.R.R.

L.E.&W.RY.

SANDUSKY HARBOR, OHIO
PROPOSED IMPROVEMENTS

TO ACCOMPANY REPORT OF SURVEY MADE UNDER AUTHORITY OF THE RIVER AND HARBOR ACT OF MARCH 4, 1913.

U.S. Engineer Office Cleveland, Ohio

Scale of Feet

1000 0 1000 2000 3000 4000 5000

Drawn by ... *Traced by* ... *Checked by* ...

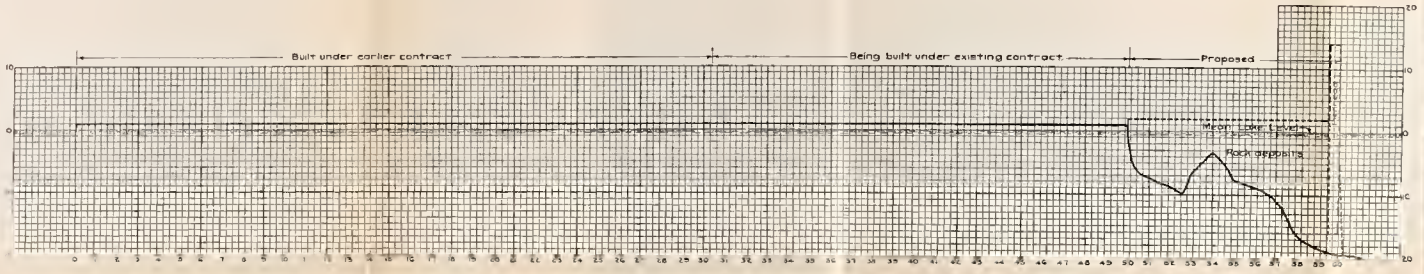
Approved February 17, 1914 and forwarded with report of same date.

Major Engineers.

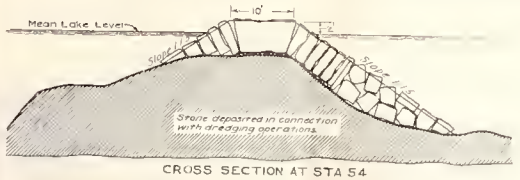
Note:

All depths referred to mean lake level 1860-1875, elevation 572.8 ft. above mean tide at New York.

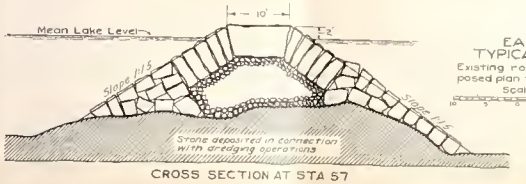
6 ft. contour ... 12 ft. contour ... 18 ft. contour



EAST JETTY - CENTER LINE PROFILE

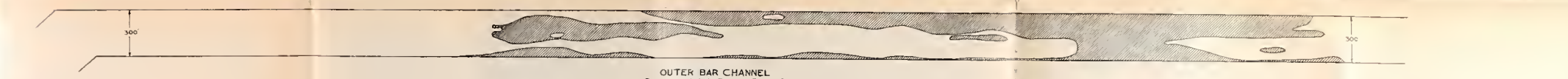


CROSS SECTION AT STA 54

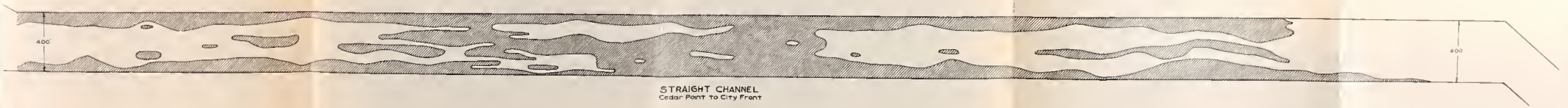


CROSS SECTION AT STA 57

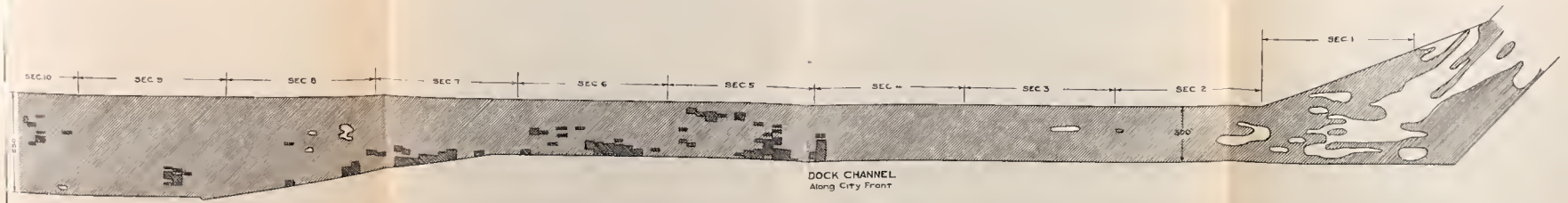
EAST JETTY
TYPICAL SECTIONS
Existing rock deposit and proposed plan for completion
Scale of feet



OUTER BAR CHANNEL
Deep water in Lake Erie to Cedar Point



STRAIGHT CHANNEL
Cedar Point to City Front



DOCK CHANNEL
Along City Front

CHANNELS

Soft materials above -23 ft.

Hard rock above -22 ft.

SANDUSKY HARBOR, OHIO
PROPOSED IMPROVEMENTS

TO ACCOMPANY REPORT OF SURVEY MADE UNDER AUTHORITY OF THE RIVER AND HARBOR ACT OF MARCH 4, 1913.

U.S. Engineer Office Cleveland, Ohio

Scale of Feet

0 100 200 1000 1800

Drawn by C.L.P. Traced by C.L.P. Checked by R.H.P.

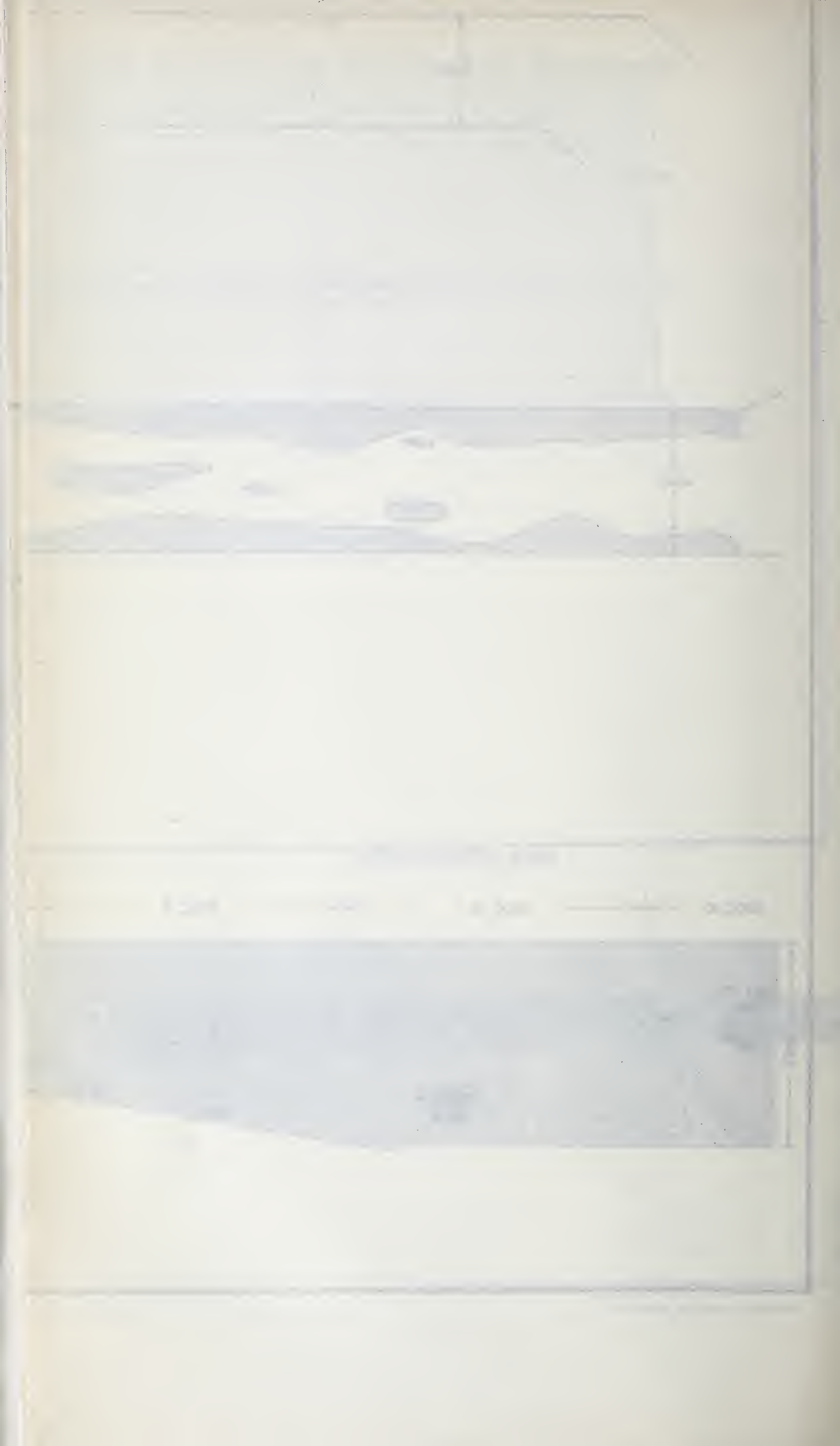
Approved February 17, 1914 and forwarded with report of same date.

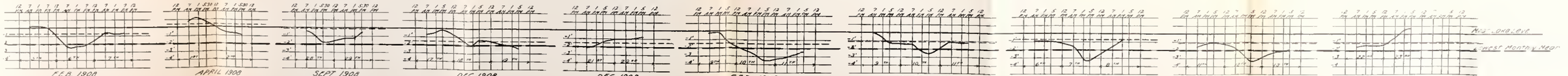
Major, Engineers

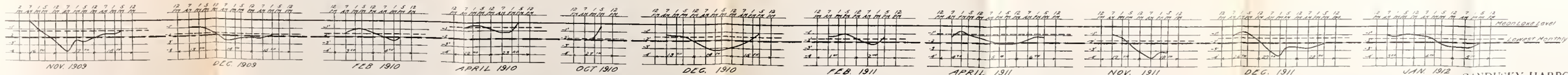
Note.

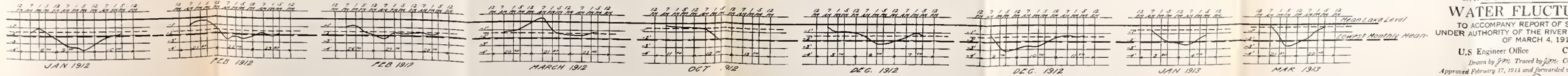
All levels referred to mean lake level 1860-1876, elevation 572.8 ft. above mean tide at New York.

House Doc. No. 871 ; 63d Cong., 2d Sess.









Mean for each month above considered indicated - - - - - - -

SANDUSKY HARBOR, OHIO

WATER FLUCTUATIONS

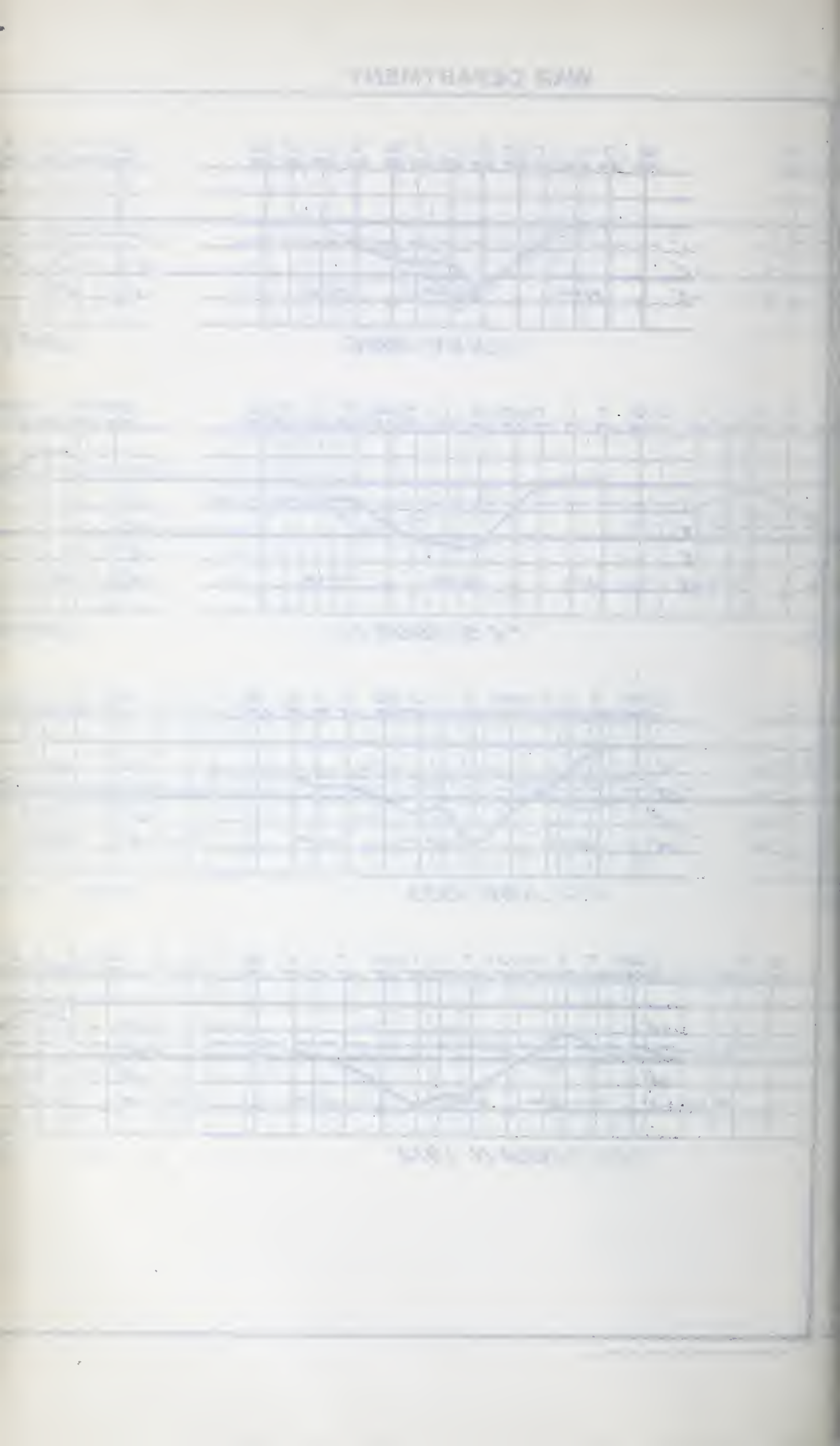
TO ACCOMPANY REPORT OF SURVEY MADE UNDER AUTHORITY OF THE RIVER AND HARBOR ACT OF MARCH 4, 1913.

U.S. Engineer Office Cleveland, Ohio

Drawn by JJC. Traced by JJC. Checked by ?

Approved February 17, 1914 and forwarded with report of same date.

Major, Engineers.

Note: All levels referred to mean lake level 1860-1876, elevation 572.6 ft. above mean tide at New York.

House Doc. No. 871 ; 63d Cong., 2d Sess.